Configuring Cell-Mode MPLS on IOS Platforms

Overview

The chapter details the cell-mode IOS MPLS implementation, giving detailed configuration, monitoring and debugging guidelines. It also covers configuration of MPLS on IOS-based ATM platforms (routers; Lightstream 1010, Catalyst 8510 and Catalyst 8540 ATM switches).

It includes the following topics:

- Configuring and Monitoring Label-Controlled ATM (LC-ATM) Multiprotocol Label Switching (MPLS)
- Configuring LC-ATM MPLS over ATM Virtual Path (VP)
- Monitoring LC-ATM MPLS on IOS platforms

Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

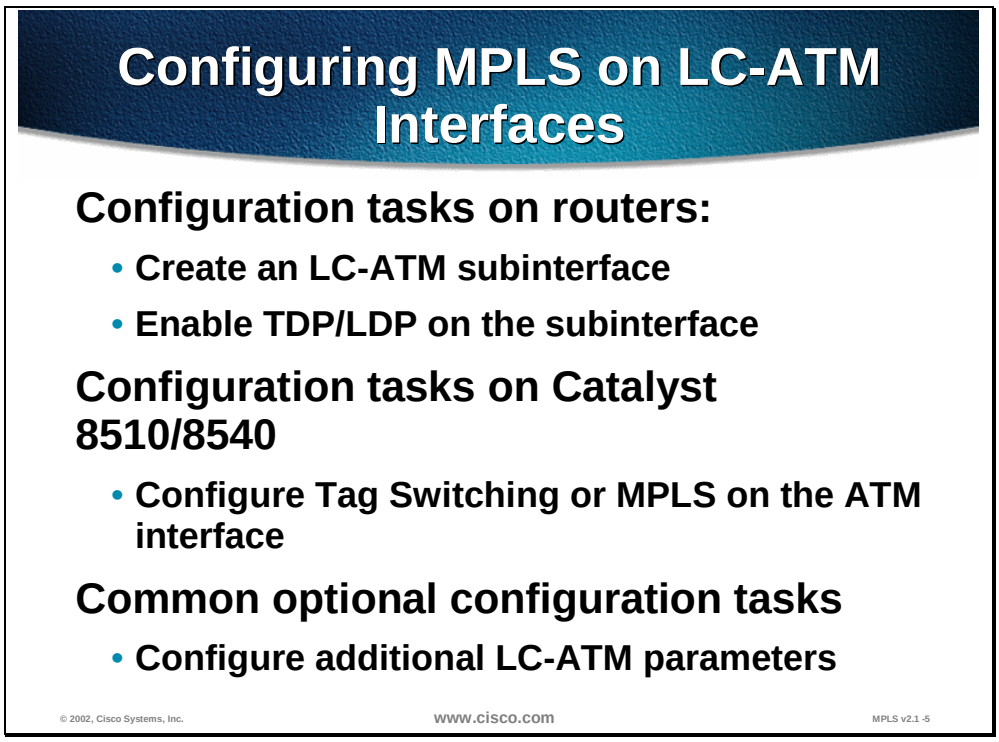
- Configure cell-mode MPLS on ATM interfaces on IOS platforms
- Configure cell-mode MPLS on ATM Virtual Path on IOS platforms
- Monitor and troubleshoot cell-mode MPLS on IOS platforms

Configuring and Monitoring LC-ATM MPLS

Objectives

Upon completion of this section, you will be able to perform the following tasks:

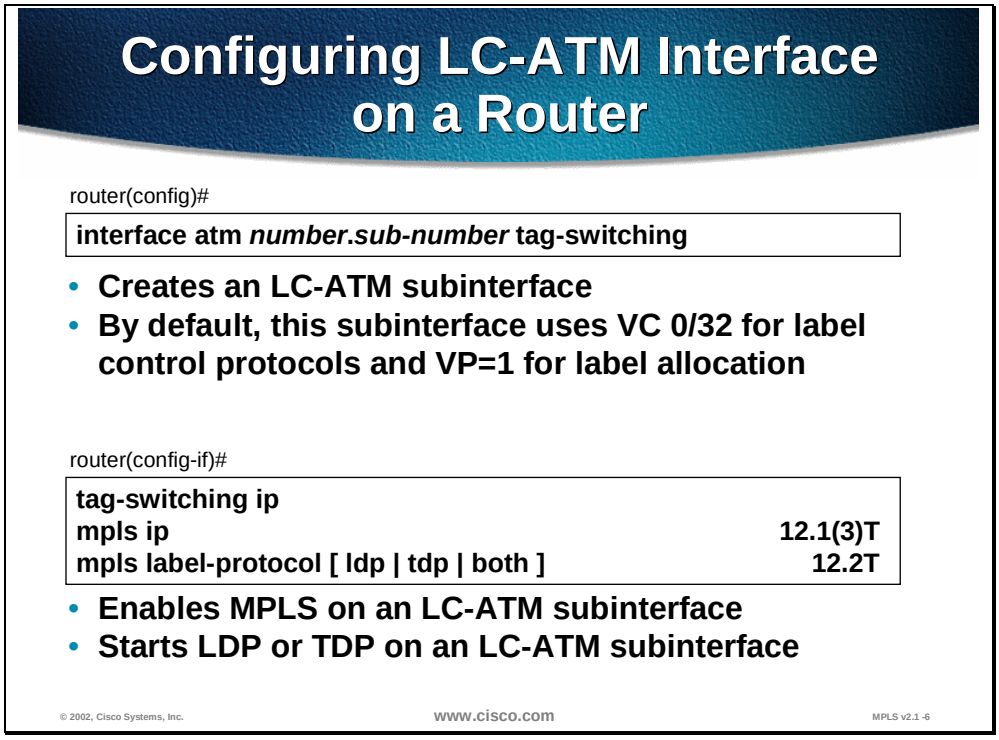
- Configure Tag Switching and MPLS on router LC-ATM interfaces
- Configure Tag Switching and MPLS on IOS-based ATM switches



The configuration of cell-mode MPLS differs from frame-mode. There is an additional command that specifies the type of the subinterface. Instead of enabling point-to-point or multipoint the interface is set to tag-switching mode (this enables cell-mode MPLS instead of the default frame-mode).

Once the ATM subinterface type is specified use the MPLS configuration commands to enable MPLS on the interface. MPLS type (cell-mode versus. frame mode) is determined from the type of subinterface.

Note On ATM switches there is no need for an additional command because they only run cell-mode MPLS.



On IOS routers subinterfaces are typically used. Use the **tag-switching** keyword to specify the type of subinterface when entering interface configuration mode. This command specifies that cell-mode MPLS should be used instead of frame-mode.

Use the MPLS configuration command **mpls ip** to actually enable MPLS.

After using both commands the router will create the control virtual circuit with VPI/VCI=0/32 to establish an IP adjacency with the directly connected ATM switch. This VC is used for TDP or LDP and the routing protocol used in the network.

Optionally, the label distribution protocol can be changed. By default, Cisco routers use TDP. There should be no need to enable both protocols since there is only one device on the other side of this link.

tag-switching ip

To enable tag switching of IPv4 packets on an interface, use the **tag-switching ip** interface configuration command. To disable IP tag switching on an interface, use the **no** form of this command.

tag-switching ip

no tag-switching ip

Defaults

This feature is disabled by default.

mpls ip

This command has the same function as **tag-switching ip**.

mpls label-protocol [tdp | ldp | both]

To select the label distribution protocol to be used on an interface, use the **mpls label-protocol** command. Use the **no** form to revert to the default label distribution protocol.

mpls label-protocol <protocol>
no mpls label-protocol <protocol>

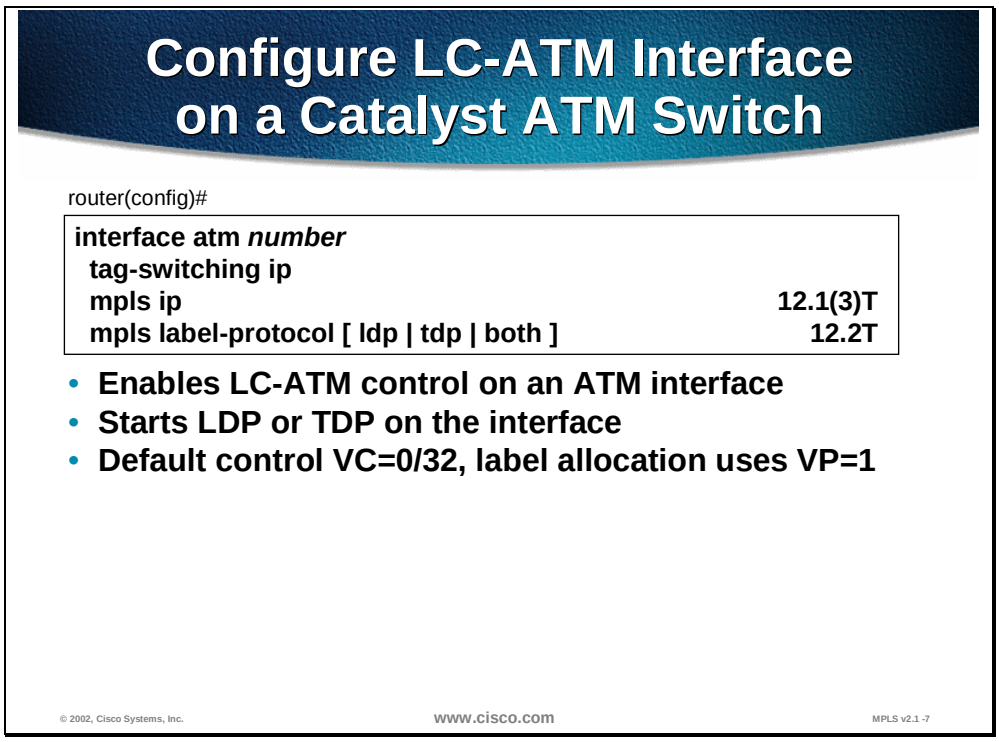
Syntax Description

This command has one argument:

tdp	enables TDP on an interface
ldp	enables LDP on an interface
both	enables TDP and LDP on an interface

Defaults

Tag Distribution Protocol is the default protocol.



Use these commands to enable MPLS on an interface of a Catalyst ATM switch—cell-mode MPLS is implied. Enabling both distribution protocols can be useful in a mixed environment when the supported protocol for every device connected to the switch does not need to be determined.

Once the TDP/LDP adjacency is established (over virtual circuit 0/32) the devices start negotiating LVCs. By default, all LVCs use VPI value 1.

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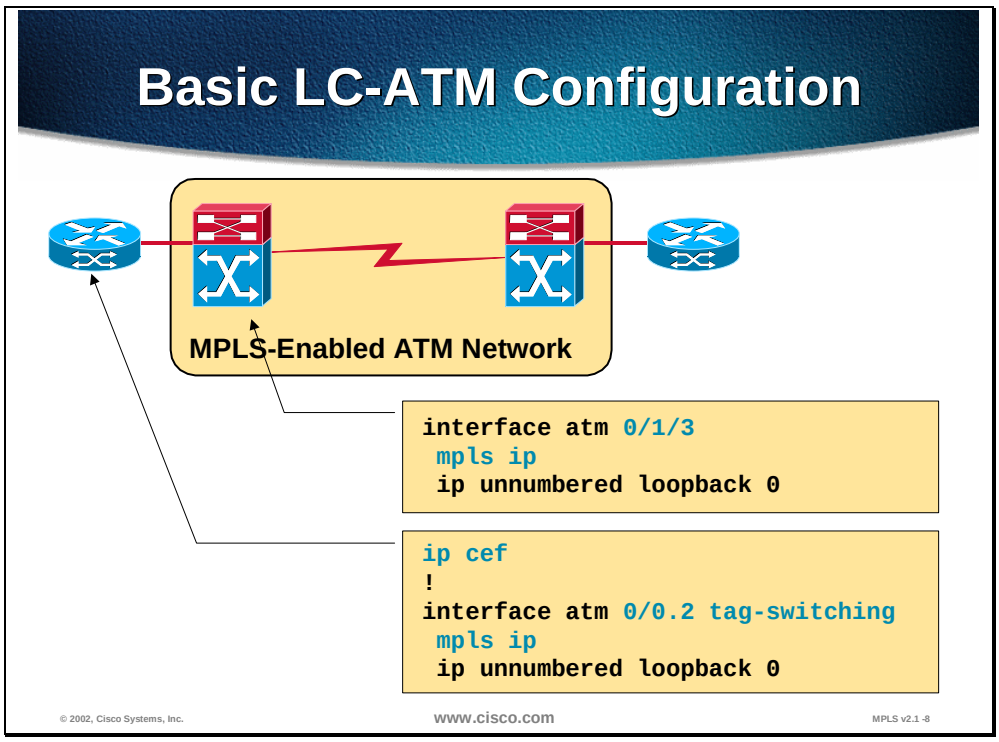
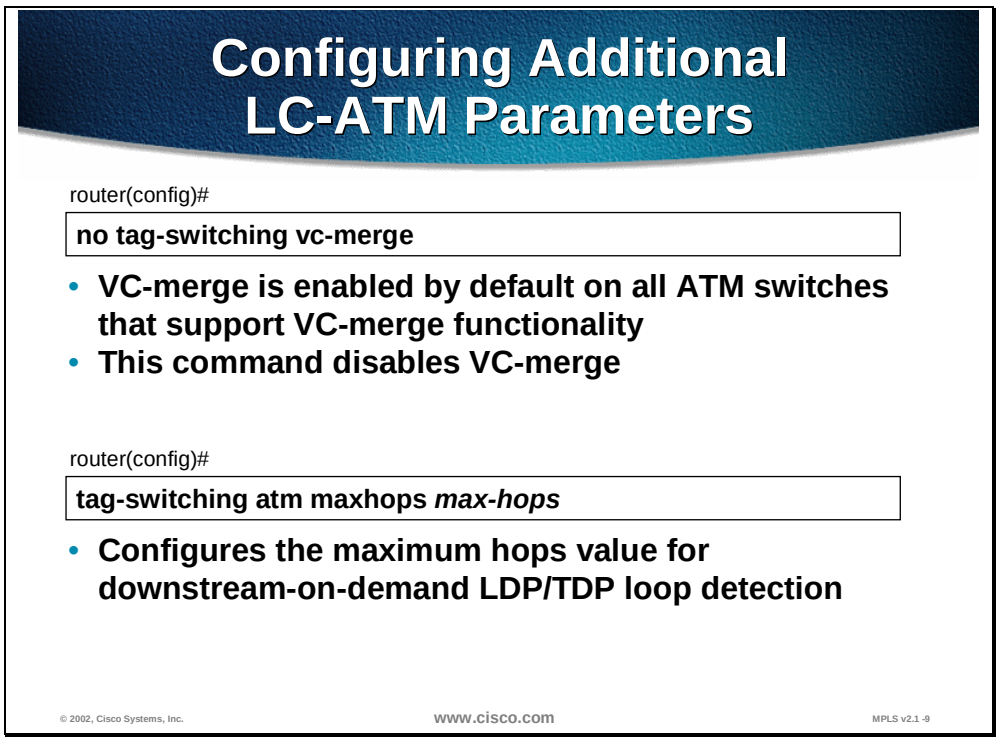


To enable cell-mode MPLS between a router and a switch ensure that the router uses the tag-switching type for the subinterface.

To successfully establish label distribution session both devices need to use the same protocol (TDP or LDP). Both devices should use the same parameters for the control VC (default VPI/VCI=0/32). There should be an intersection between the proposed ranges of VPI and VCI values.

By default, all Cisco devices use VPI value 1 for dynamically established LVCs. Additionally, Cisco routers require CEF switching to enable MPLS.



tag-switching vc-merge

A large ATM network using cell-mode MPLS may experience a problem of having too many LVCs. MPLS itself is very similar to ATM but it normally merges multiple sources into one destination (label). This is an unusual situation for ATM and would cause mixing of cells belonging to different packets. The end device that needs to reassemble the cells into a packet would not be able to differentiate between cells because they use the same VPI/VCI value pair. There are two solutions:

- Create a distinct label for every source-destination pair (may require a large number of LVCs)
- Merge multiple sources to use the same destination label, by buffering the incoming cells in the ATM switch and forwarding them when the complete frame has been assembled. This option is called **vc-merge**.

VC-merge is enabled by default on all devices that support it, and must be explicitly disabled if it is not desired.

Note The ATM switch that does the **vc-merge** function buffers the entire AAL5 frames as they are received, then forwards them contiguously, without mixing cells. The end device therefore has no problem reassembling each individual frame correctly. The drawback of using **vc-merge** is the increased store-and-forward delay incurred by the ATM switch

Note VC merge support requires FC-PFQ on the route processor of Lightstream 1010 or Catalyst 8510 MSR. If you do not have FC-PFQ, and you try to enable VC merge, the LVCs remain point-to-point.

Command Syntax

To control whether vc-merge (multipoint-to-point) is supported for unicast tag VCs, use the **tag-switching atm vc-merge** global configuration command. Use the **no** form of this command to disable this feature.

tag-switching atm vc-merge
no tag-switching atm vc-merge

Defaults

Enabled.

tag-switching atm maxhops

Router ID can be used in LDP to detect routing information loops in ATM networks during the downstream-on-demand label allocation process. TDP does not support this option and relies exclusively on hop-count carried in the TDP request and reply packets to detect loops during the downstream-on-demand label allocation. You can configure the maximum number of hops allowed during a TDP or LDP label allocation by using **tag-switching atm maxhops** command global configuration command. Use the **no** form of this command to ignore the hop count.

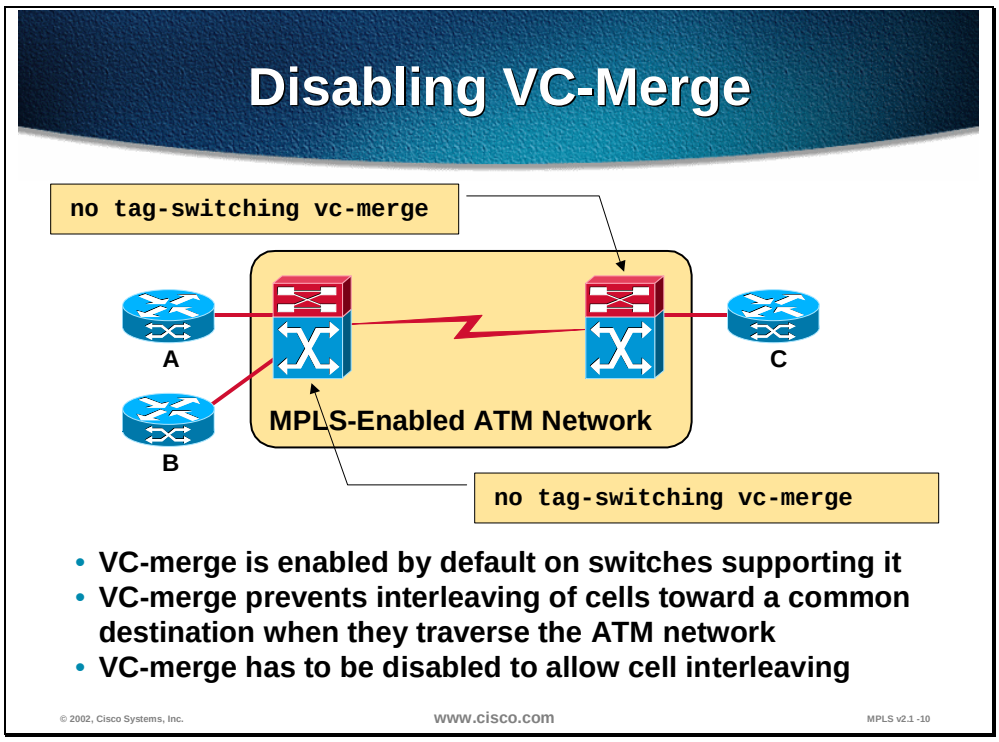
tag-switching atm maxhops [number]
no tag-switching atm maxhops

Syntax Description

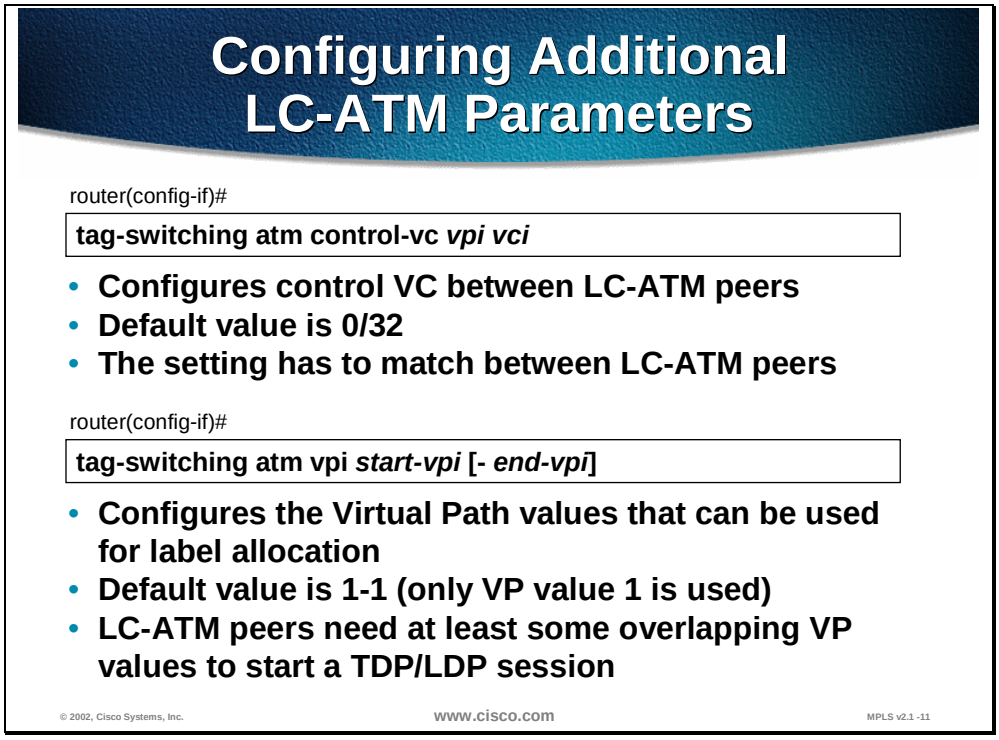
number	(Optional) Maximum hop count.

Defaults

Unlimited.



The VC-merge feature is enabled by default on all switches that support it. If for some reason the feature is not required (that is, small network, different line speeds, buffering not desired) it can be disabled. Disabling vc-merge results in the ability to interleave cells, but must create an LVC for every source-destination pair.



Use the **tag-switching atm control-vc** to change the default VPI and VCI numbers used for the control VC. Use the **tag-switching atm vpi** commands to change the default VPI values for the LVCs.

tag-switching atm control-vc

To configure the VPI and VCI to be used for the initial link to the Tag Switching peer device, use the **tag-switching atm control-vc** interface configuration command. The initial link is used to establish the TDP session and to carry non-IP traffic. To clear the interface configuration, use the **no** form of this command.

tag-switching atm control-vc vpi vci

no tag-switching atm control-vc vpi vci

Syntax Description

vpi Virtual path identifier.

vci Virtual channel identifier.

Defaults

Control VC uses VPI/VCI value pair 0/32.

tag-switching atm vpi

To configure the range of values to use in the VPI field for tag VCs, use the **tag-switching atm vpi** interface configuration command. To clear the interface configuration, use the **no** form of this command.

tag-switching atm vpi vpi [- vpi]

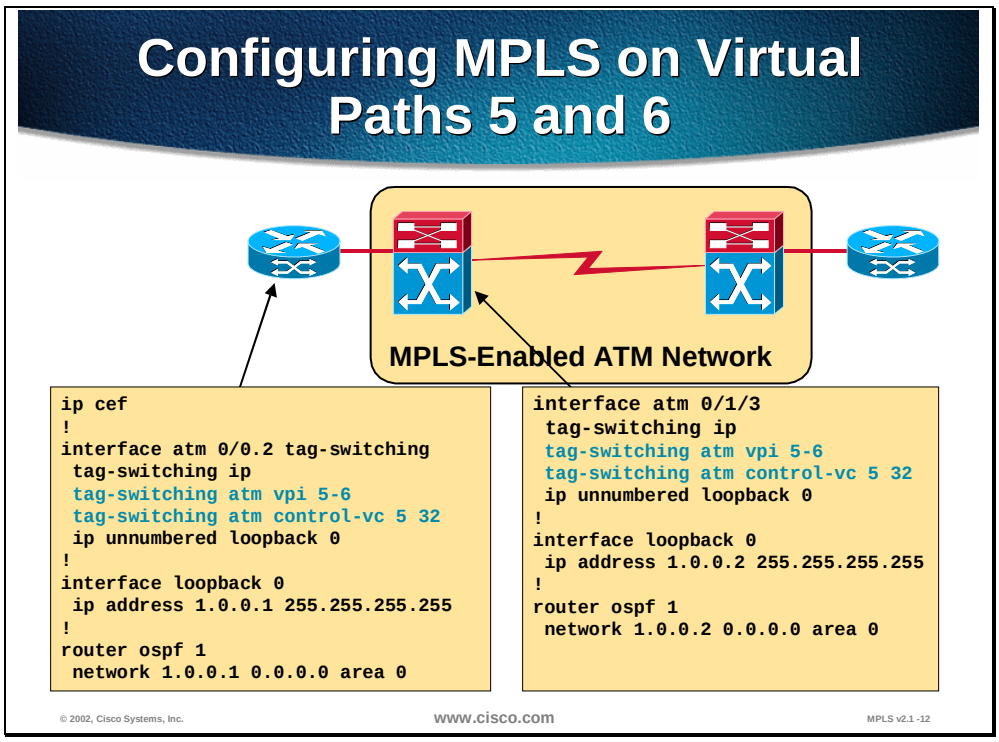
no tag-switching atm vpi vpi [- vpi]

Syntax Description

vpi	Virtual path identifier (low end of range).
- *vpi*	(Optional) Virtual path identifier (high end of range).

Defaults

VPI value 1 is used for LVCs.



The example above shows how to change the default VPI range from 1-1 to 5-6. The control VC can also use the VPI value used for LVCs. In this example the control VC is using VPI=5 and VCI=32. Note that the values much match on each neighbor.

Summary

The configuration of cell-mode MPLS is similar to that of frame-mode MPLS. The main differences are:

- Setting the type of ATM interface to tag-switching (on routers it enables cell-mode MPLS)
- Some ATM specific parameters are accessed through **tag-switching atm** commands (routers and switches), for example: control VC, VPI range, VC-merge and the maximum number of hops across the ATM network.

Lesson Review

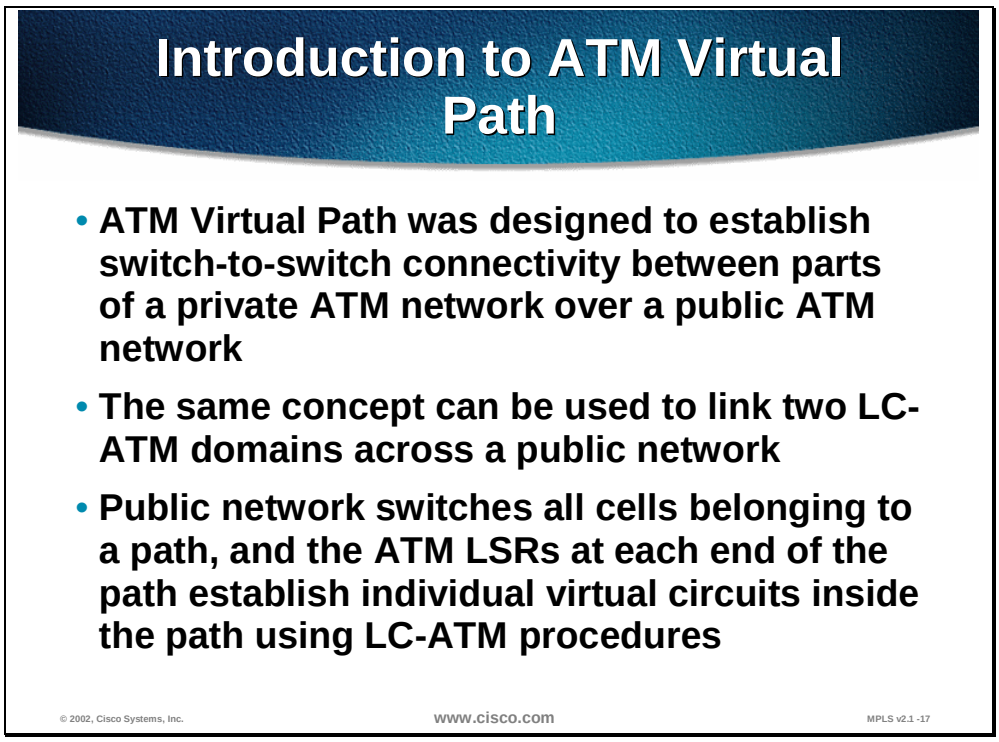
1. What are the steps needed to configure an LC-ATM interface on a router?
2. What are the steps needed to configure an LC-ATM interface on an ATM switch?
3. Which additional LC-ATM parameters can you configure?

Configuring LC-ATM MPLS over ATM Virtual Path

Objectives

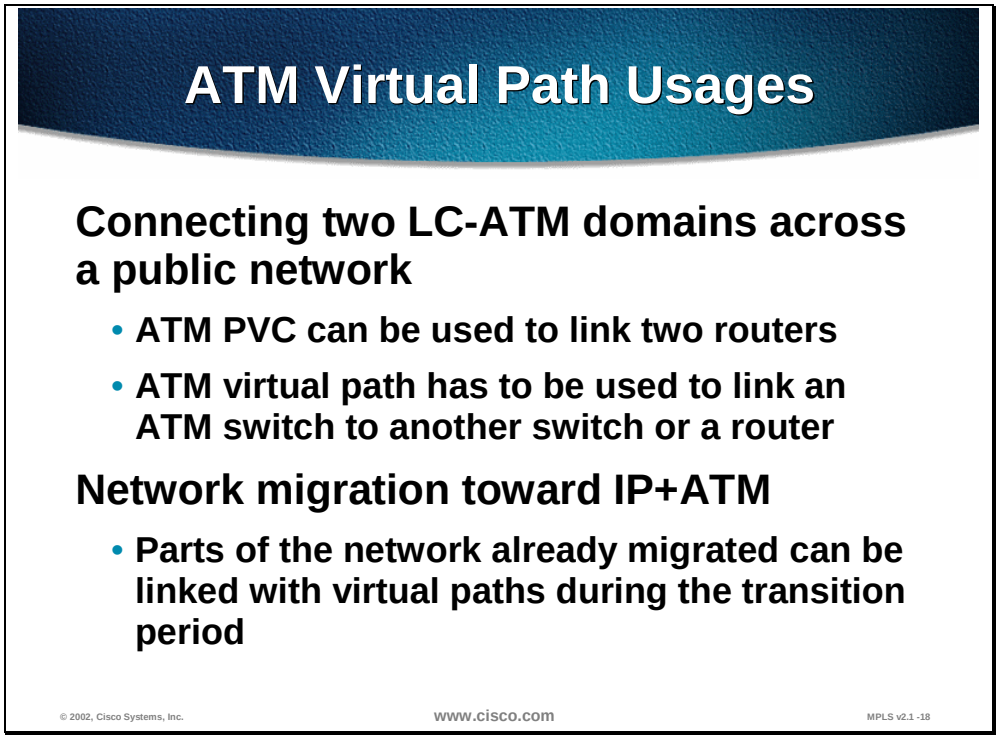
Upon completion of this section, you will be able to perform the following tasks:

- Identify the scenarios where it might be advantageous to run MPLS over ATM Virtual Path (VP)
- Describe the potential router – switch combinations that support MPLS over ATM VP
- Configure MPLS over ATM VP



A virtual path is a collection of virtual circuits with a common VPI. ATM switches are forwarding cells based on VPI value only (VCI is ignored). This is useful if one or more switches in the network do not support MPLS. A static virtual path can be established between switches that support MPLS. They can establish a control VC across the virtual path and negotiate LVCs with the virtual path's VPI used to set the label range.

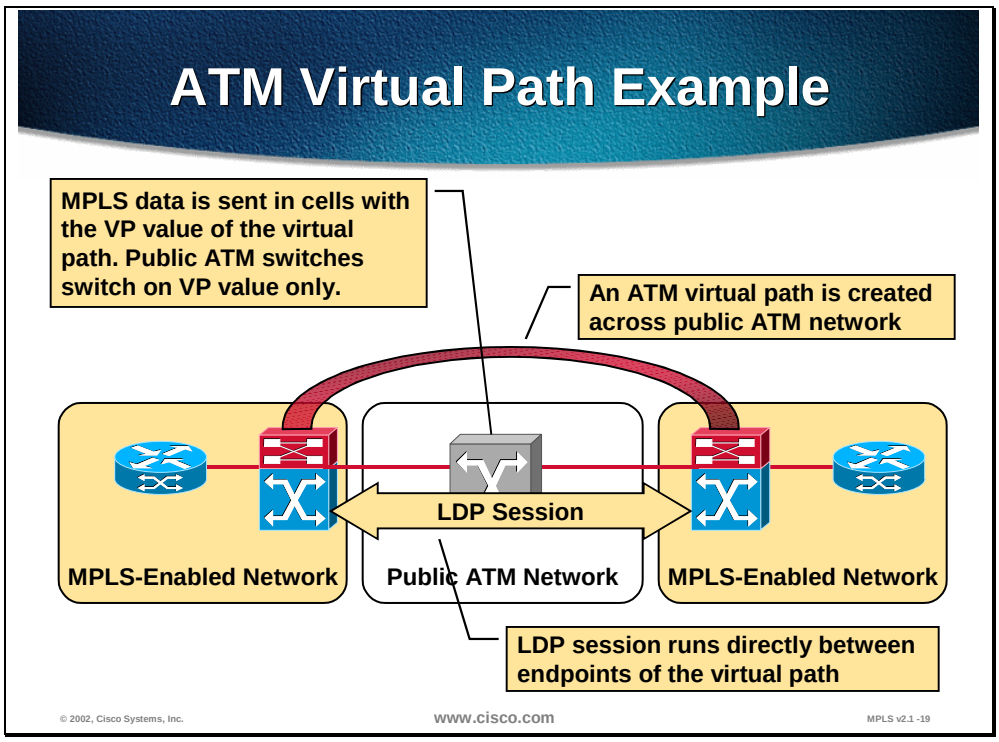
This solution is typically used when a public ATM network is used to interconnect remote sites that use ATM switches.



There are two options when trying to enable MPLS across a public ATM network:

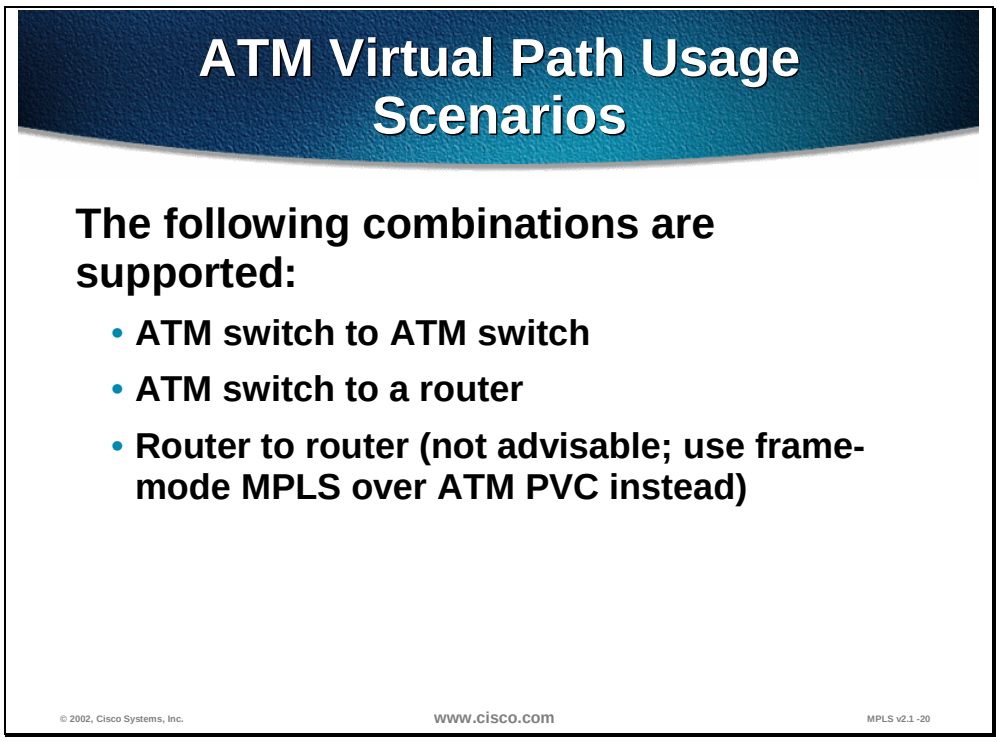
- Virtual circuit—frame-mode MPLS has to be used because ATM switches in the path do not support MPLS. Only routers support frame-mode MPLS. Switches cannot use frame-mode MPLS and, therefore, cannot use virtual circuits.
- Virtual path—cell-mode MPLS can be used between routers or switches on both ends of the virtual path.

Virtual paths can also be used in the migration stages when sites are being reconnected to MPLS-enabled switches. Virtual paths can be established from an MPLS-enabled switch to all devices connected to ATM switches that do not support MPLS. The network can then slowly be migrated towards IP+ATM without the need for an “overnight” full migration.



To enable cell-mode MPLS across a virtual path, the control VC should be changed to use the VPI of the virtual path. A router or a switch will then establish an adjacency with a router or a switch on the other end of the virtual path.

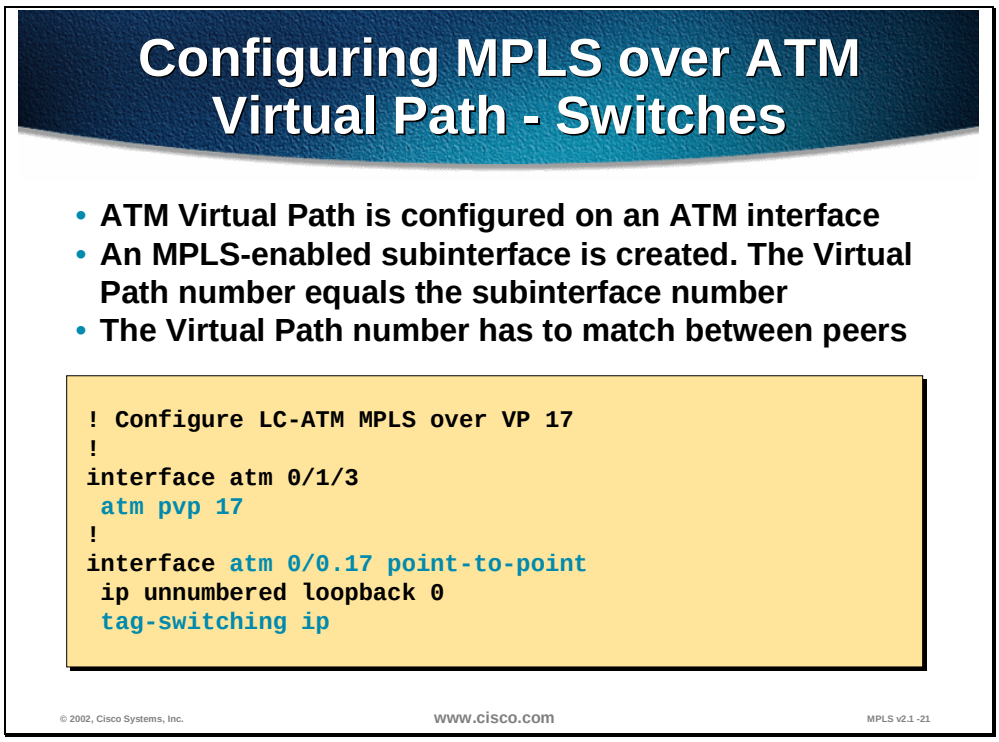
Note It is mandatory that the same VPI be used on both ends of the path because the VPI value is part of the LDP VP-range negotiation.



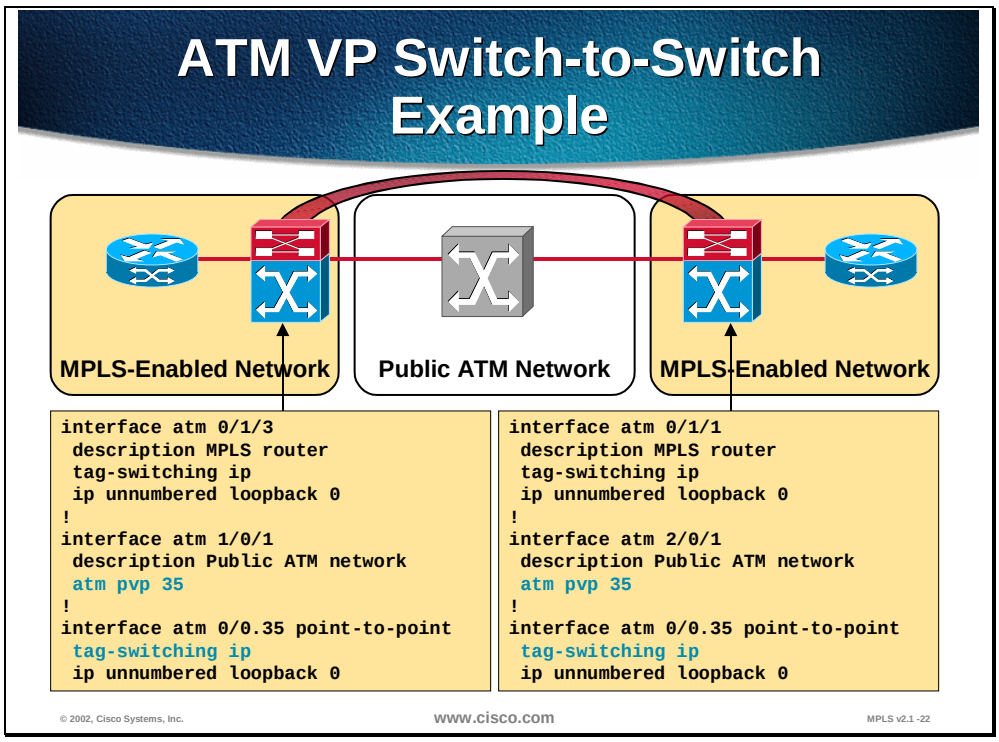
A virtual path can be used to connect any pair of devices across a public ATM network:

- Switch to switch
- Switch to router
- Router to router (PVCs with frame-mode MPLS are usually used in this case)

The first two options allow MPLS to run across a public ATM network. The third option can also be used but it has no advantage over using frame-mode MPLS across a PVC. On the contrary it requires a reservation of a large number of virtual circuits (virtual path equals 65536 virtual circuits).



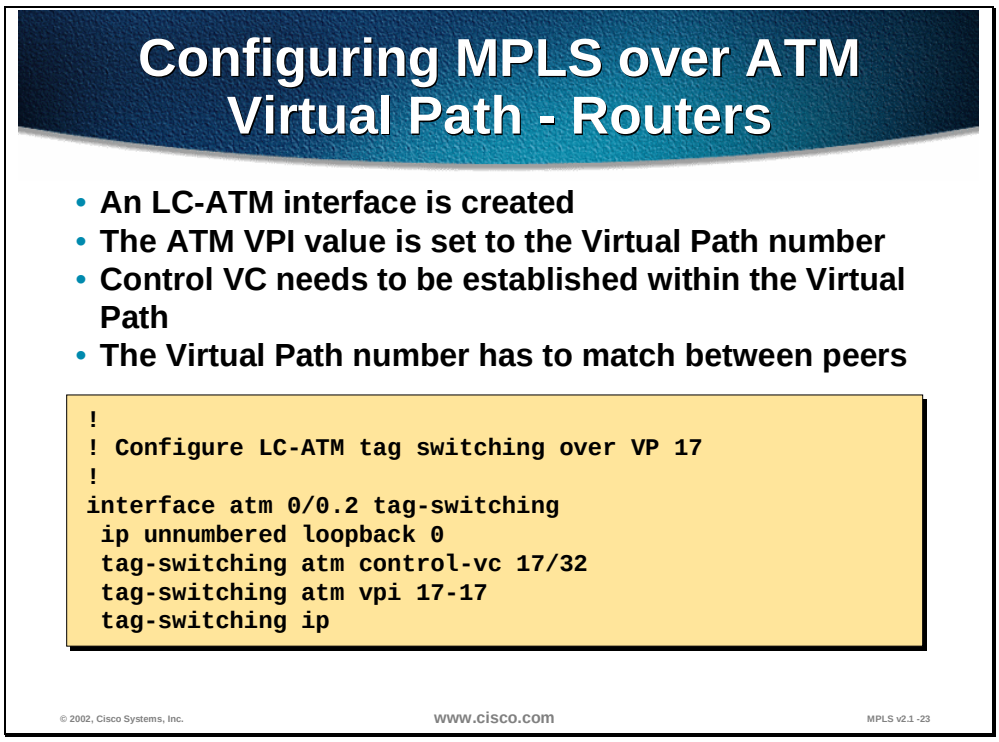
In this example a virtual path with VPI=17 is created and a subinterface with the VPI number as the subinterface number is configured with cell-mode MPLS functionality.



This example shows the configuration of both MPLS-enabled ATM switches connected by a virtual path across a public ATM network.

The VPI value has to be the same on the first and last hop in the path. The ATM provider can use any VPI on any other link.

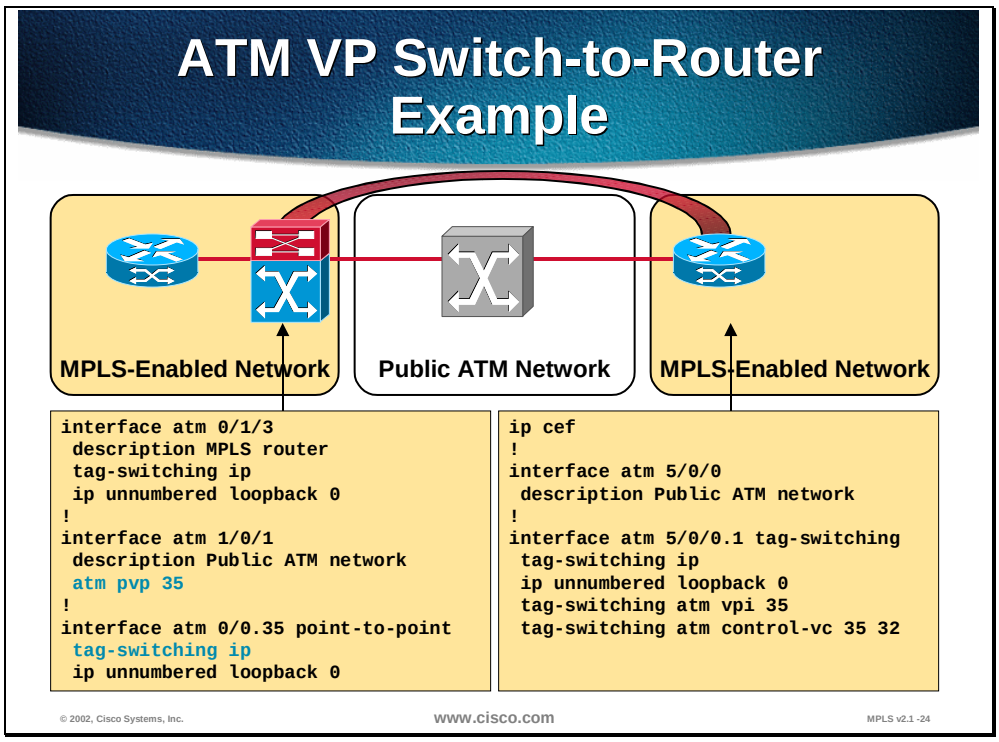
Note This example does not change the parameters of the control VC. An additional PVC needs to be established for the control VC (0/32).



To simplify the provisioning of the connection across a public ATM network the control VC can also be put into the virtual path.

The example above shows how the control VC can be changed to use the same VPI value used to establish the virtual path.

If the public network is forwarding cells for VPI=17 then the control VC should be put into this virtual path (17/32) and the label range has to be set to use the same VPI value (17-17).



When connecting a router and a switch through a virtual path only the parameters for the control VC and the label range on the router need to be set. The router is unaware that the control VC is not terminated on the directly connected switch. The public ATM network simply forwards all cells based on the VPI value to the other endpoint where an MPLS-enabled switch continues forwarding based on VPI **and** VCI values.

Summary

Virtual path is useful when trying to cross an ATM network that does not support MPLS. This is typically used when migrating from standard ATM to IP+ATM or when interconnecting sites across a public ATM network.

A virtual path can be established between two switches or a router and a switch. It is not recommended connecting two routers with a virtual path.

Configuration of a switch requires a PVP configuration. Configuration of a router does not require anything special (virtual path is transparent).

Lesson Review

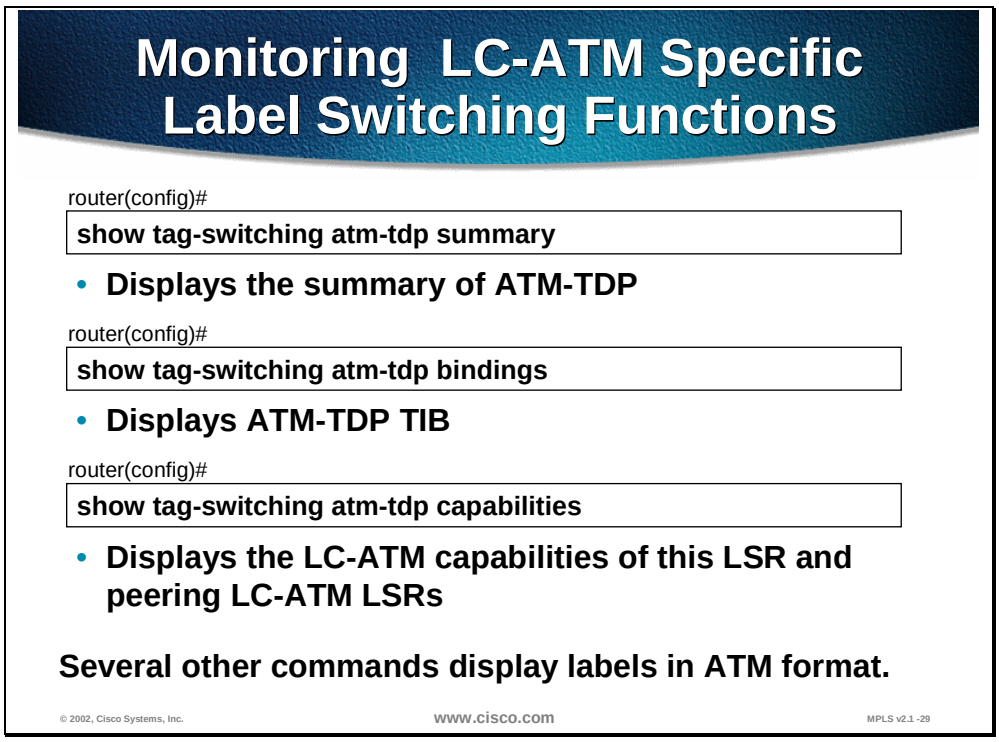
1. Why would you deploy cell-mode MPLS over an ATM virtual path?
2. How does the MPLS work over an ATM virtual path?
3. Which router/switch combinations are supported across an ATM virtual path?
4. What could be an alternate method of connecting two routers across public ATM network?
5. What are the steps needed to configure an ATM virtual path?
6. Why does the ATM virtual path number have to match between LC-ATM peers?

Monitoring LC-ATM MPLS on IOS Platforms

Objectives

Upon completion of this section, you will be able to perform the following tasks:

- Describe procedures for monitoring MPLS over LC-ATM interfaces on IOS platforms
- List the debugging commands associated with label switching, LDP, and TDP on LC-ATM interfaces



There are commands similar to **show tag-switching tdp** that display ATM specific parameters. Use a question mark to see all subcommands of **show tag-switching atm-tdp**.

show tag-switching atm-tdp summary

To display summary information on ATM tag bindings, use the **show tag-switching atm-tdp summary** privileged EXEC command.

show tag-switching atm-tdp summary

show tag-switching atm-tdp bindings

To display the requested entries from the ATM TDP tag-binding database, use the **show tag-switching atm-tdp bindings** privileged EXEC command.

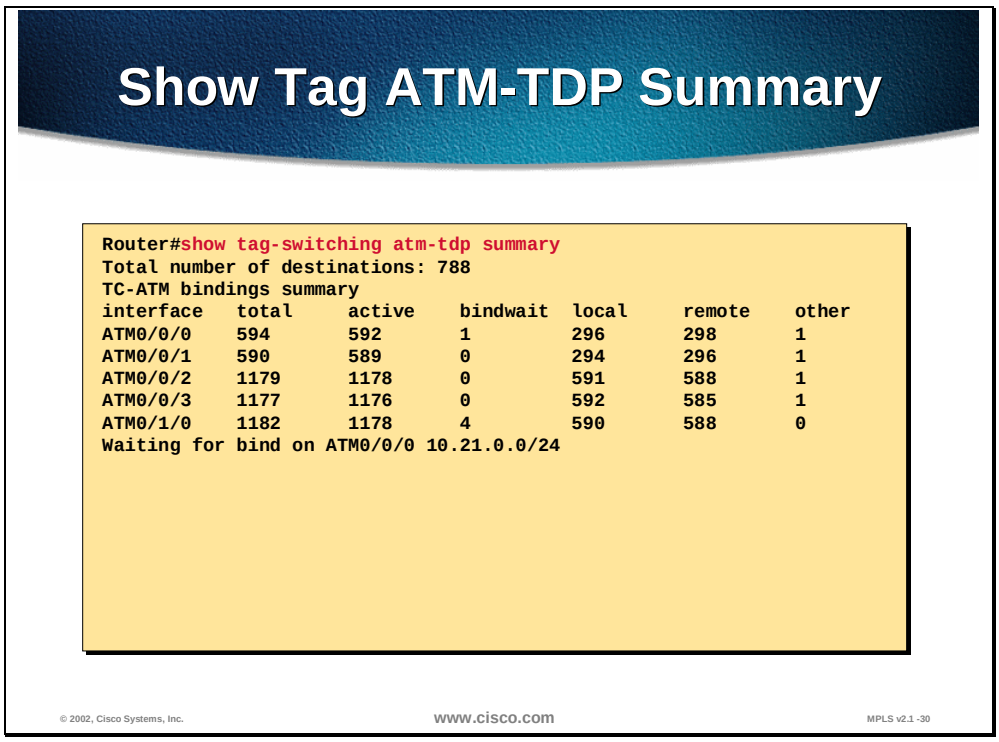
show tag-switching atm-tdp bindings [*network* **{***mask* **|** *length***}] [local-tag |** **remote-tag** *vpi vci***] [neighbor** *intf***] [remote-tag** *vpi vci***]**

Syntax Description

network	Destination prefix.
mask	Destination netmask prefix.
length	Netmask length, in the range of 1 to 32.
local-tag *vpi vci*	Selects tag values assigned by this switch.
neighbor *intf*	Selects tags assigned by a neighbor on the specified ATM interface.
remote-tag *vpi vci*	Selects tag values assigned by another switch.

show tag-switching atm-tdp capability

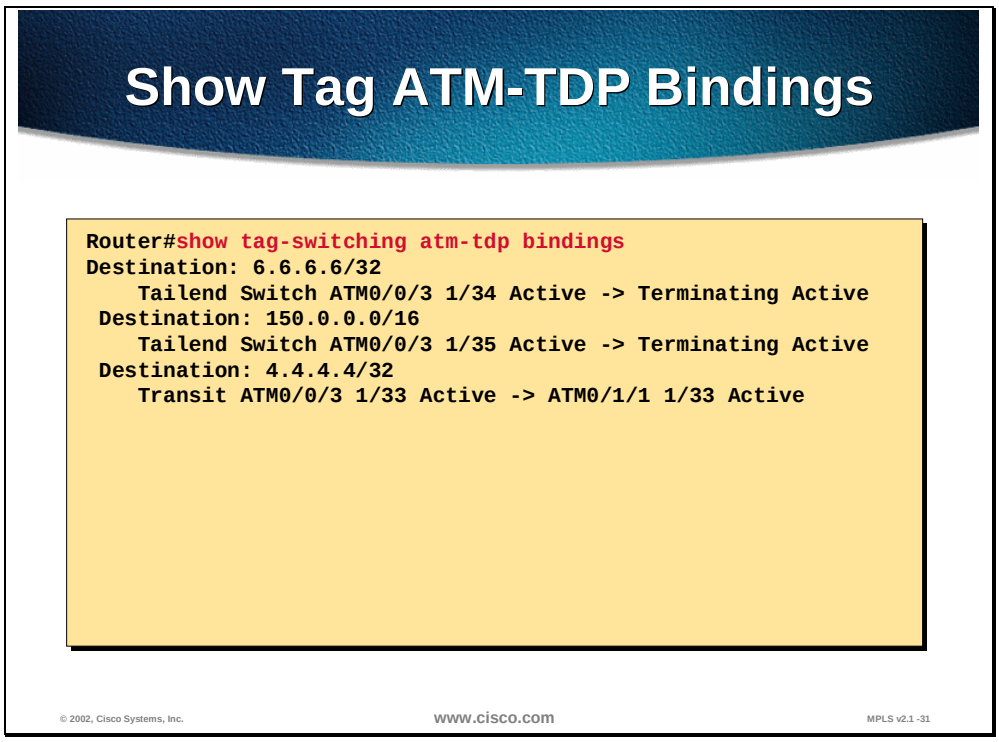
To display the ATM TDP tag capabilities for all interfaces, use the **show tag-switching atm-tdp capability** privileged EXEC command.



To display summary information on ATM tag bindings, use the **show tag-switching atm-tdp summary** privileged EXEC command.

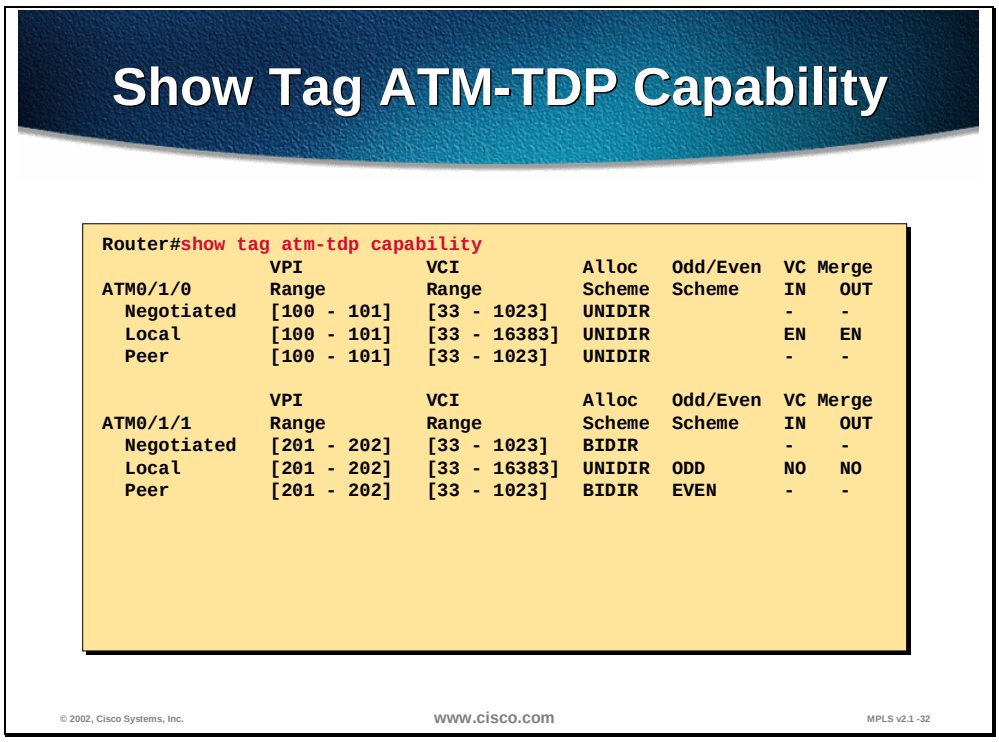
Show tag-switching atm-tdp summary field description

Total number of destinations	The number of known destination address prefixes.
interface	The name of an interface with associated ATM tag bindings.
total	The total number of ATM tags on this interface.
active	The number of ATM tags in an "active" state that are ready to use for data transfer.
bindwait	The number of bindings that are waiting for a tag assignment from the neighbor TSR.
local	The number of ATM tags assigned by this TSR on this interface.
remote	The number of ATM tags assigned by the neighbor TSR on this interface.
other	The number of ATM tags in a state other than "active" or "bindwait".
Waiting for bind on ATM0/0/0	A list of the destination address prefixes (on a particular interface) that are waiting for ATM tag assignment from the neighbor TSR.



Show tag-switching atm-tdp bindings field description

Destination 6.6.6.6/32	Destination IP address/length of netmask.
Tailend Switch	VC type: ■ Tailend—VC that terminates at this switch ■ Headend—VC that originates at this switch ■ Transit—VC that passes through this switch
ATM0/0/3	ATM interface.
1/34	VPI/VCI
Active	TVC state: ■ Active—Set up and working ■ Bindwait—Waiting for response



The **show tag-switching atm-tdp capability** command shows information about the negotiation of MPLS parameters with TDP/LDP neighbors:

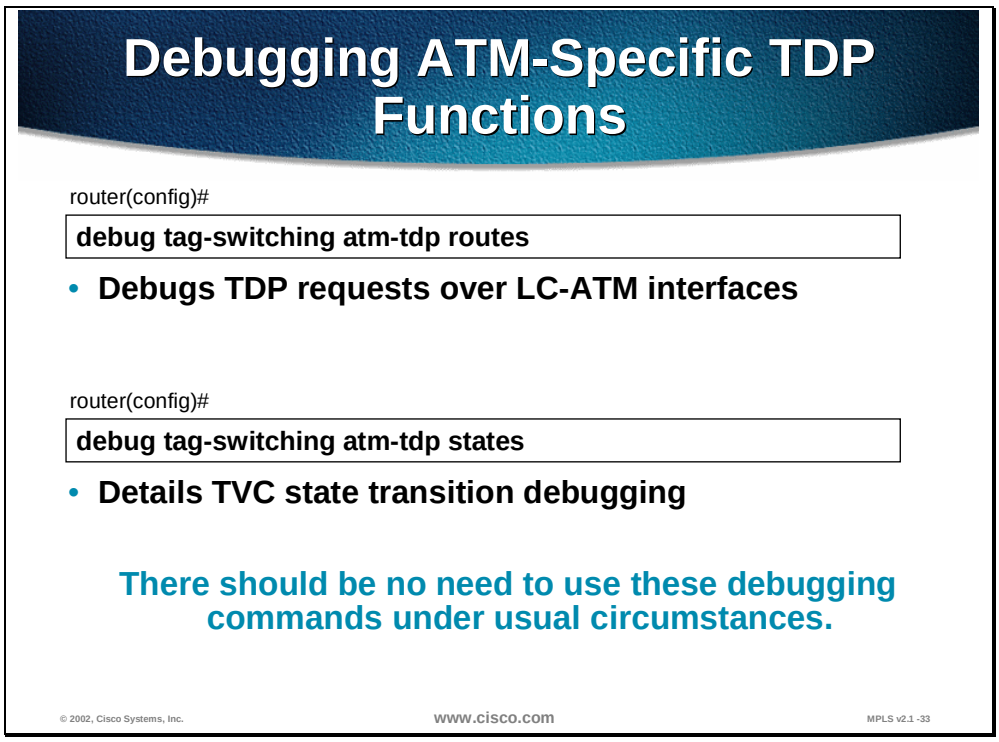
- The first line shows the negotiated (active) parameters
- The second line shows the parameters proposed by this router
- The third line shows the parameters proposed by the neighbor

Note Neighbors need to have an intersection in their proposed VPI/VCI label ranges.

Show tag-switching atm-tdp capability field description

VPI Range	Minimum and maximum number of VPIs supported on this interface.
VCI Range	Minimum and maximum number of VCIs supported on this interface.
Alloc Scheme	UNIDIR—Unidirectional capability indicates that the peer device can, within a single VPI, support binding of the same VCI to different prefixes on different directions of the link. BIDIR—Bidirectional capability indicates that within a single VPI, a single VCI can appear in one binding only. In this case, one peer device allocates bindings in the even VCI space, and the other in the odd VCI space. The system with the lower TDP identifier will assign even-numbered VCIs.

	The negotiated allocation scheme is UNIDIR, if and only if, both peer devices have UNIDIR capability. Otherwise it is BIDIR.
Odd/Even Schem	Indicates whether the local device or the peer device is assigning an odd- or even-numbered VCI when the negotiated scheme is BIDIR. It does not display any information when the negotiated scheme is UNIDIR.
VC Merge	Indicates the type of VC merge support on this interface. IN—Indicates input interface merge capability. IN accepts the following values: ■ EN—The hardware interface supports VC merge and VC merge is enabled on the device. ■ DIS—The hardware interface supports VC merge and VC merge is disabled on the device. ■ NO—The hardware interface does not support VC merge. OUT—Indicates output interface merge capability. OUT accepts the same values as the input merge side. The VC merge capability is meaningful only on ATM switches. It is not negotiated.
Negotiated	Set of options that both TDP peer devices have agreed to share on this interface. For example, the VPI or VCI allocation on either peer device remains within the negotiated ranges.
Local	Options supported locally on this interface.
Peer	Options supported by the remote TDP peer device on this interface.



The **debug tag-switching atm-tdp routes** command displays information about the state of the routes for which VCI requests are being made.

The **debug tag-switching atm-tdp states** command displays information about LVC state transitions as they occur.

Summary

Cisco IOS software includes a large list of **show** commands that can ease troubleshooting of MPLS networks. Some commands shown in this section are:

- **show tag-switching atm-tdp summary**
- **show tag-switching atm-tdp bindings**
- **show tag-switching atm-tdp capability**

There are also many debugging commands that can help troubleshoot a problem when **show** commands are not sufficient. Debugging commands should be used with extreme caution.

Lesson Review

1. Which command would you use to display the LC-ATM capabilities of your device?
2. What is the unidirectional label allocation on an LC-ATM interface?
3. How can you identify an ATM switch by looking at the **show tag-switching atm-tdp bindings** printout?
4. How can you display Label Switched Paths that haven't been fully established yet?

Summary

After completing this lesson, you should be able to perform the following tasks:

- Configure cell-mode MPLS on ATM interfaces on IOS platforms
- Configure cell-mode MPLS on ATM VP on IOS platforms
- Monitor and troubleshoot cell-mode MPLS on IOS platforms

